

# Data Assimilation to Extract Soil Moisture Information From SMAP Observations

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- Motivation
- Method
  - SMAP NN Retrievals
  - Data Assimilation Experiments
- Results
  - Impact on Soil Moisture Climatology
  - Evaluation vs. In Situ Measurements
  - Impact on Evaporation and Runoff
- Conclusions

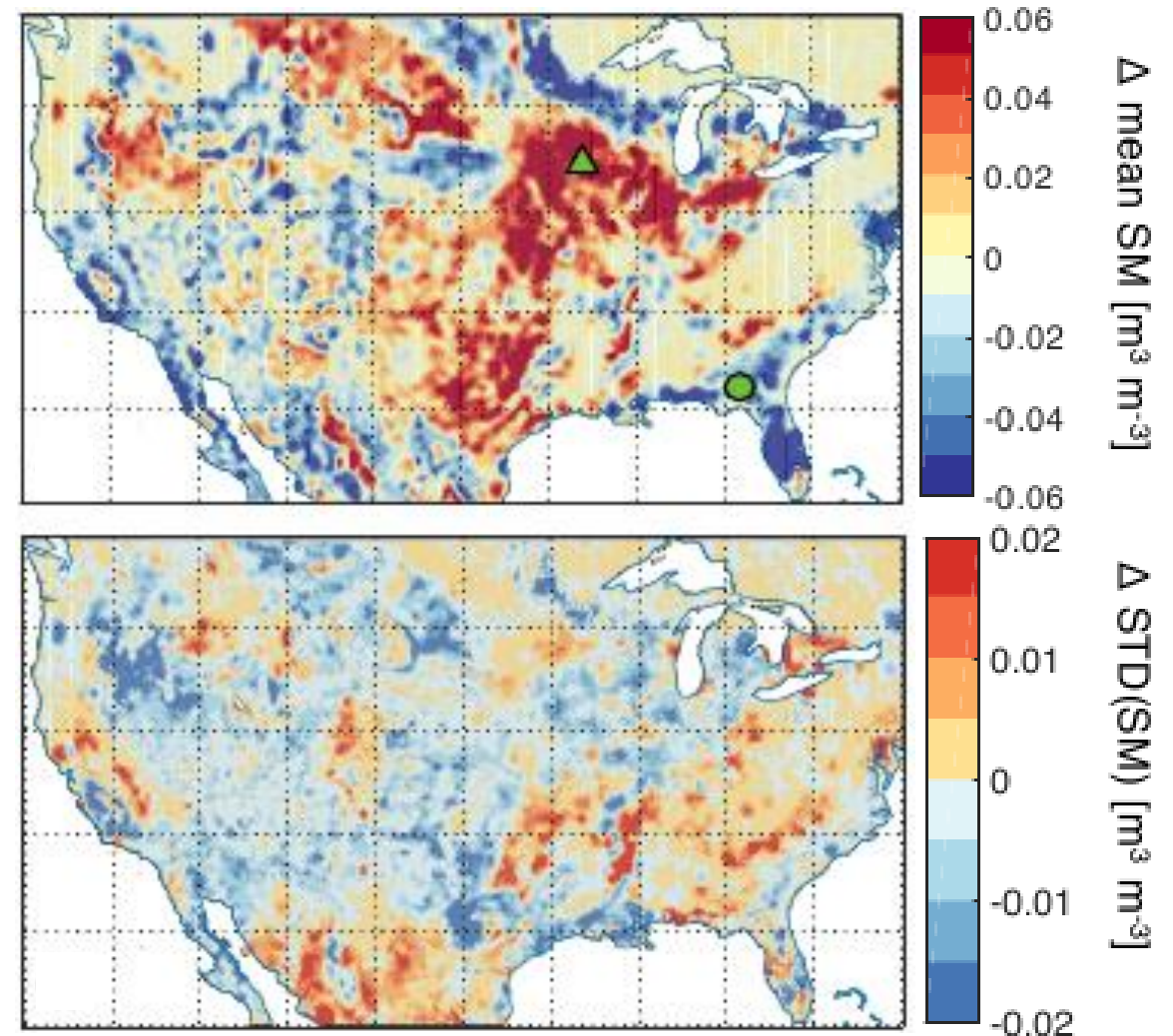
### Objective:

Efficiently assimilate SMAP observations into the NASA Catchment model.

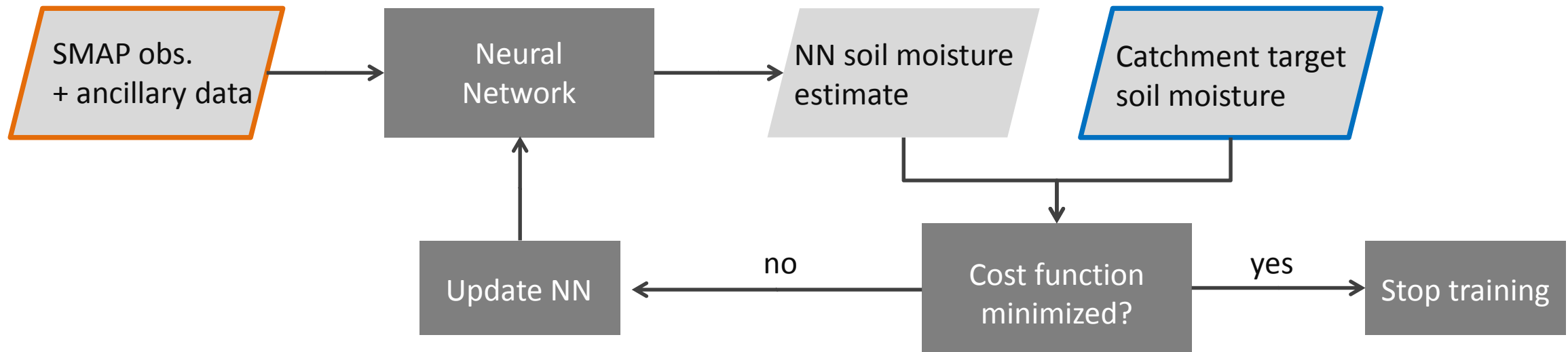
### Issue:

Localized observation rescaling removes some independent information from very skillful SMAP retrievals.

***Compare which rescaling method uses independent satellite information most efficiently.***



**Fig 1.** Effect of localized bias correction (CDF-matching) on soil moisture retrieval.



**Fig 2.** NN training procedure.

- Neural Networks (NN) retrieve soil moisture in model climatology (mean, variance, higher moments) (*Kolassa et al. 2017, in review*)
- **Global** dynamic range and bias from [model \(GEOS-5\)](#)
- Spatial and temporal patterns from [observations \(SMAP + ancillary data\)](#)

***Can NN retrievals reduce the need for further bias correction prior to assimilation and thus avoid removing independent satellite information?***

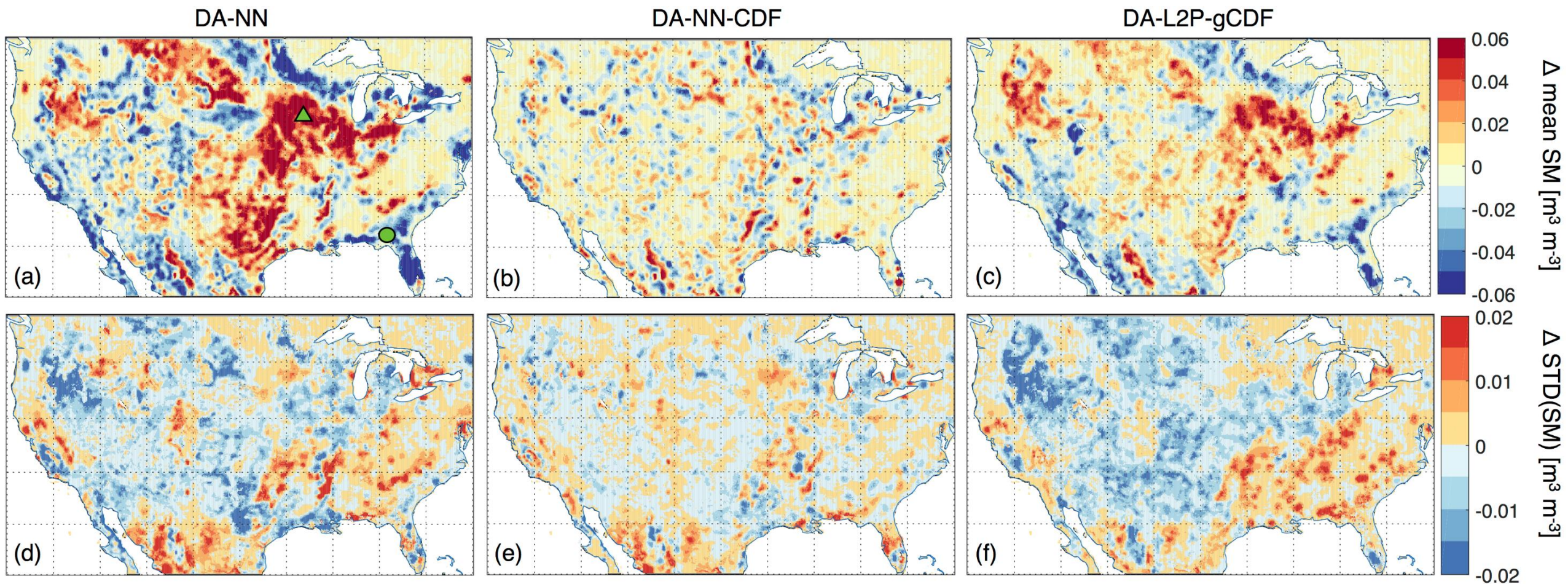
## Experiments

- OL Model-only simulation (no assimilation)
  - **DA-NN:** Assimilate NN retrievals **without further bias correction**
  - **DA-NN-CDF:** Assimilate NN retrievals with **local bias correction**
  - **DA-L2P-gCDF:** Assimilate L2 passive retrievals (*O'Neill et al., 2015*) with **global bias correction**
  - **DA-L4:** Assimilate **locally rescaled brightness temperatures in SMAP L4\_SM system**
- 
- April 2015 – March 2017
  - 9 km EASE v2 grid
  - Contiguous United States
  - 3-hourly analysis

→ Assess skill improvements of DA over OL at SMAP core validation sites

*(Jackson et al., 2016; Colliander et al., 2017)*



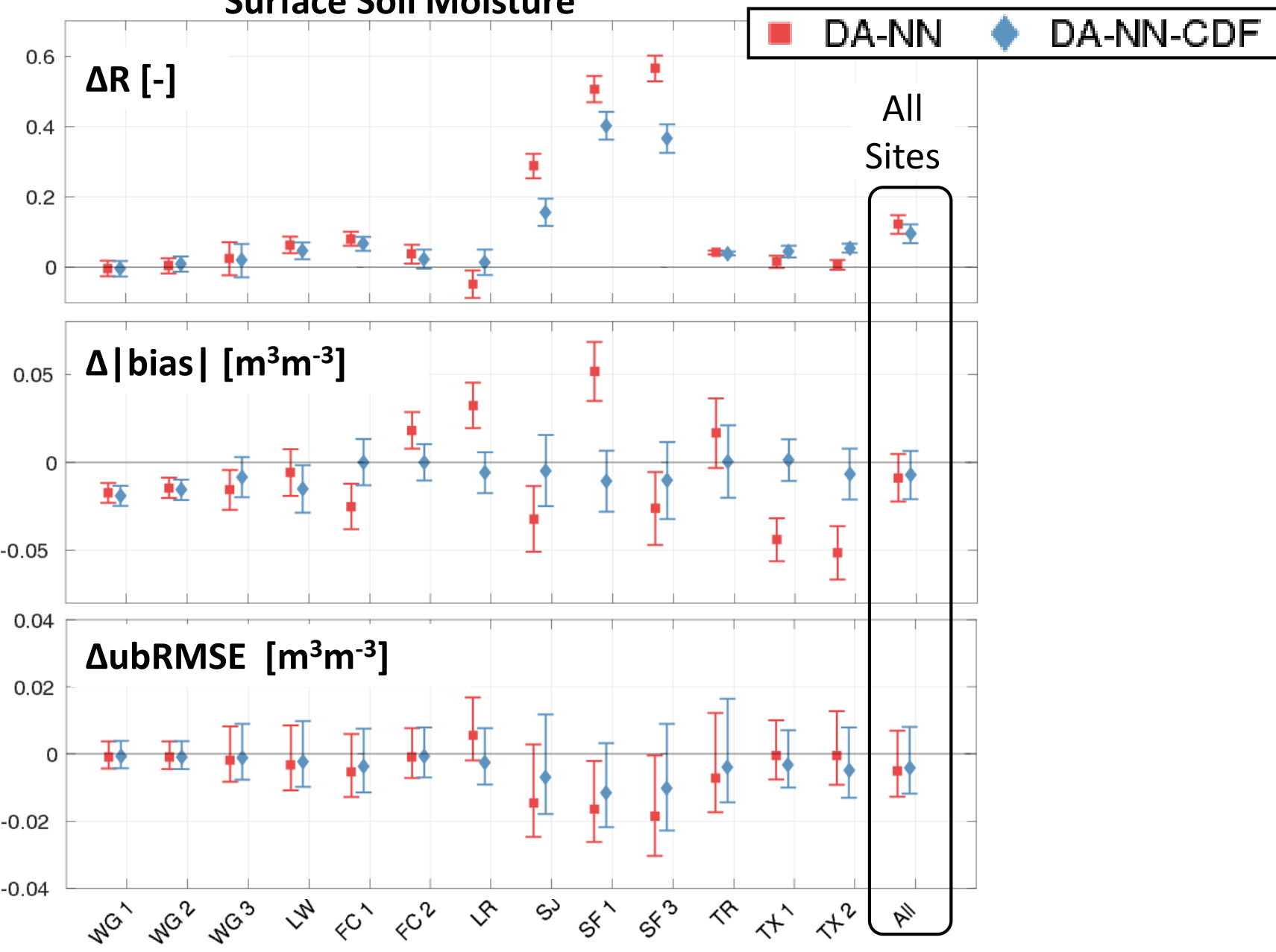


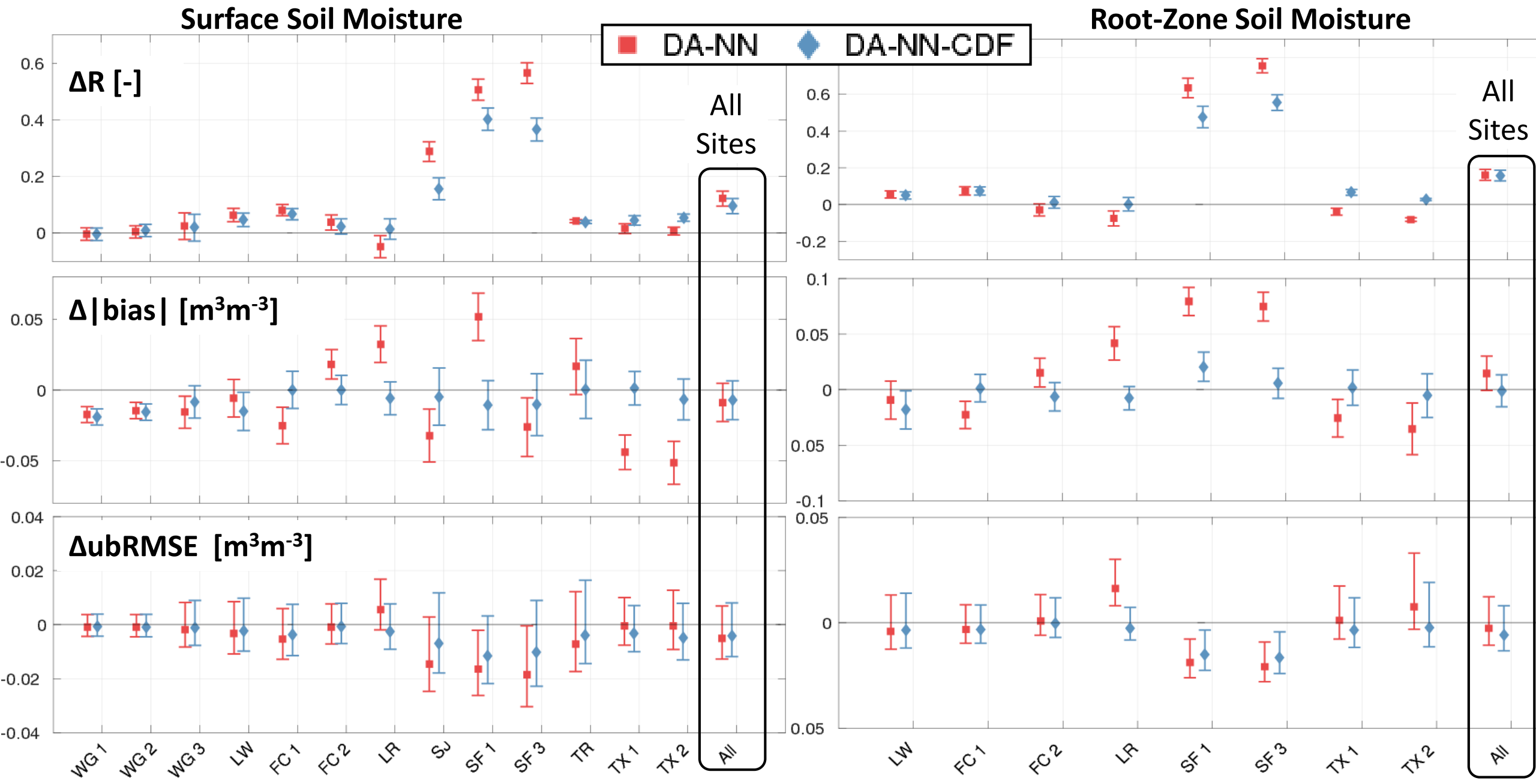
**Fig 3.** Difference (OL minus DA) in soil moisture (top row) mean and (bottom row) standard deviation.

**Global rescaling experiments introduce more of the SMAP retrieval information.**

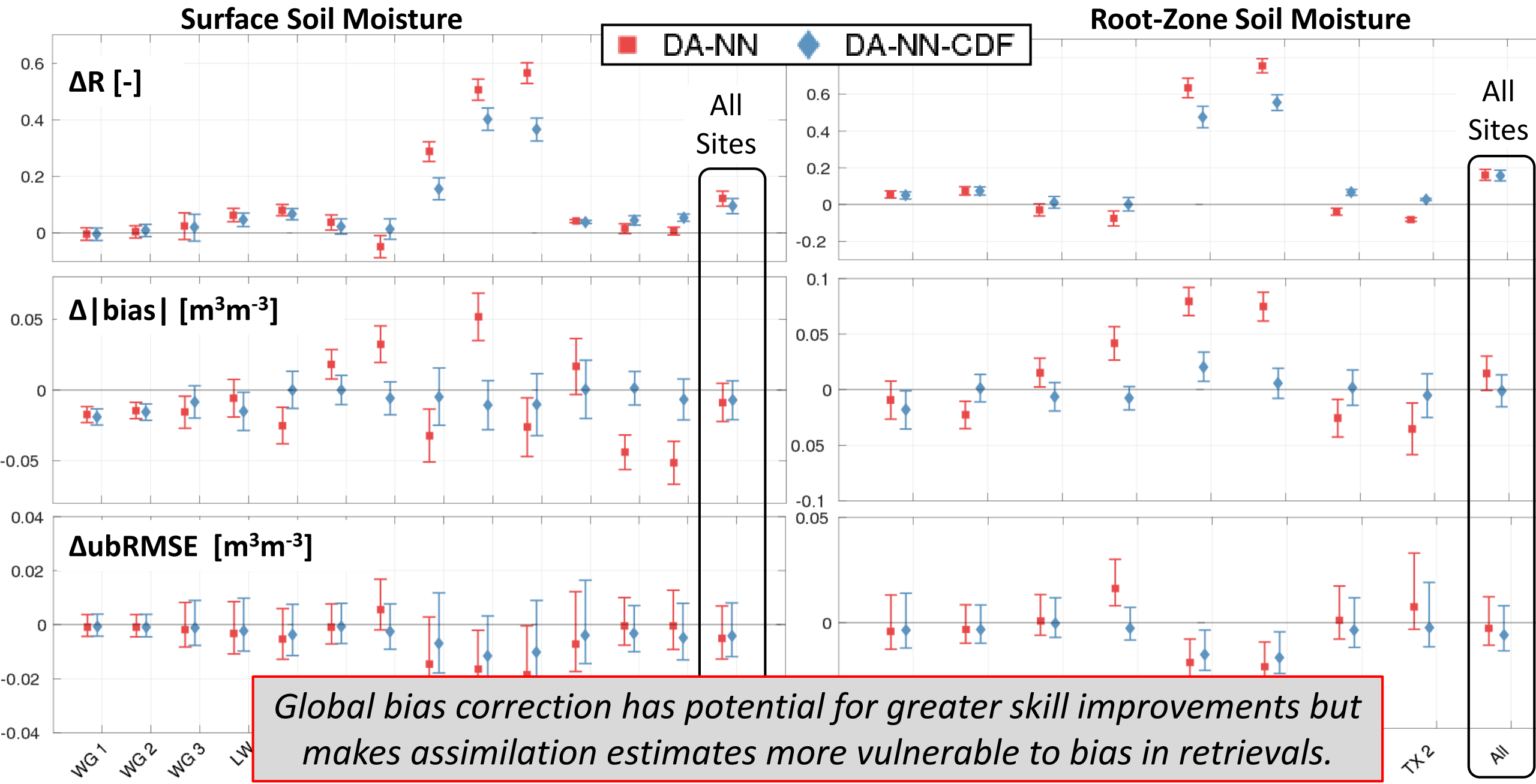
- ▲ South Fork watershed
- Little River watershed

## Surface Soil Moisture

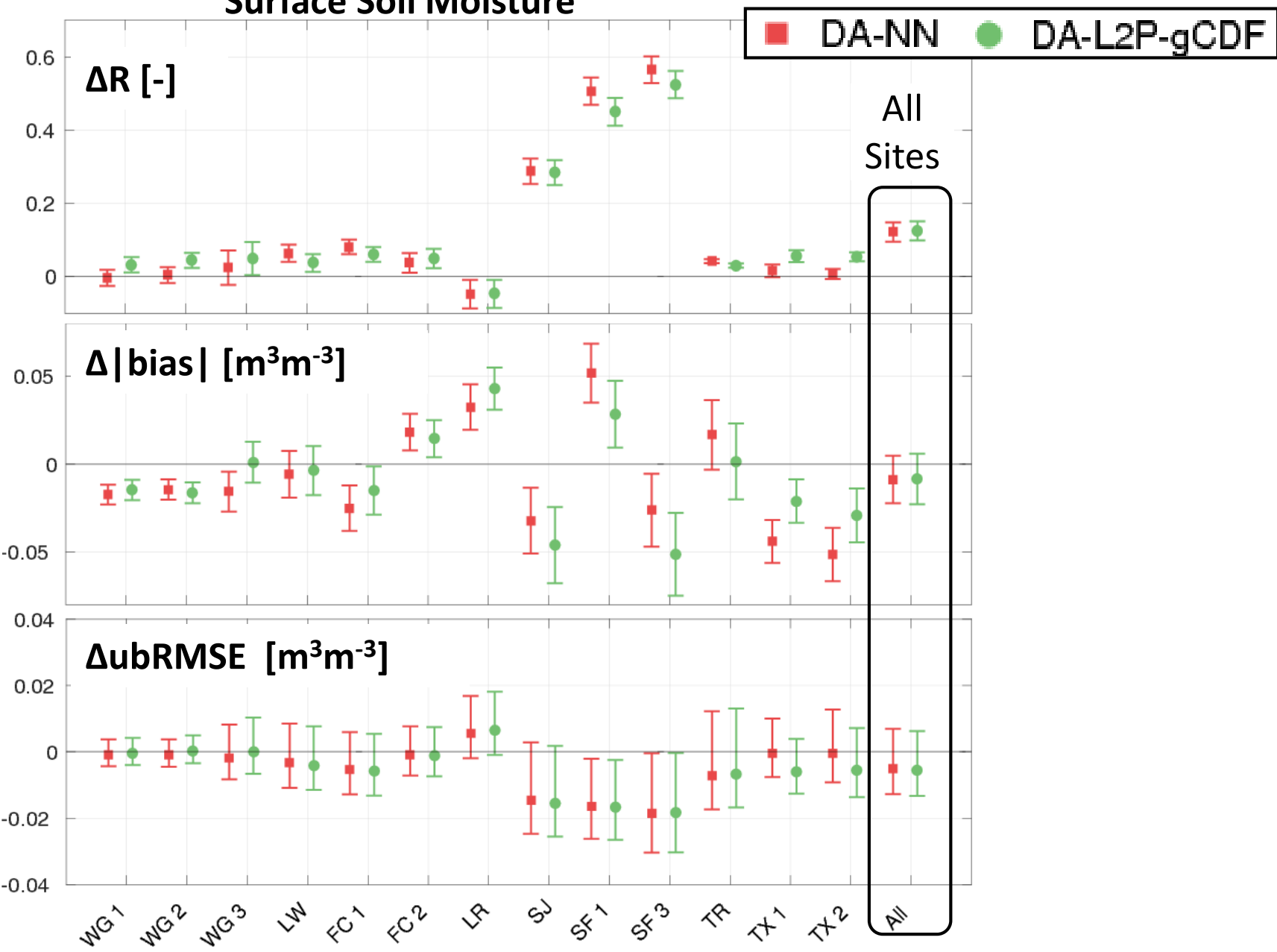


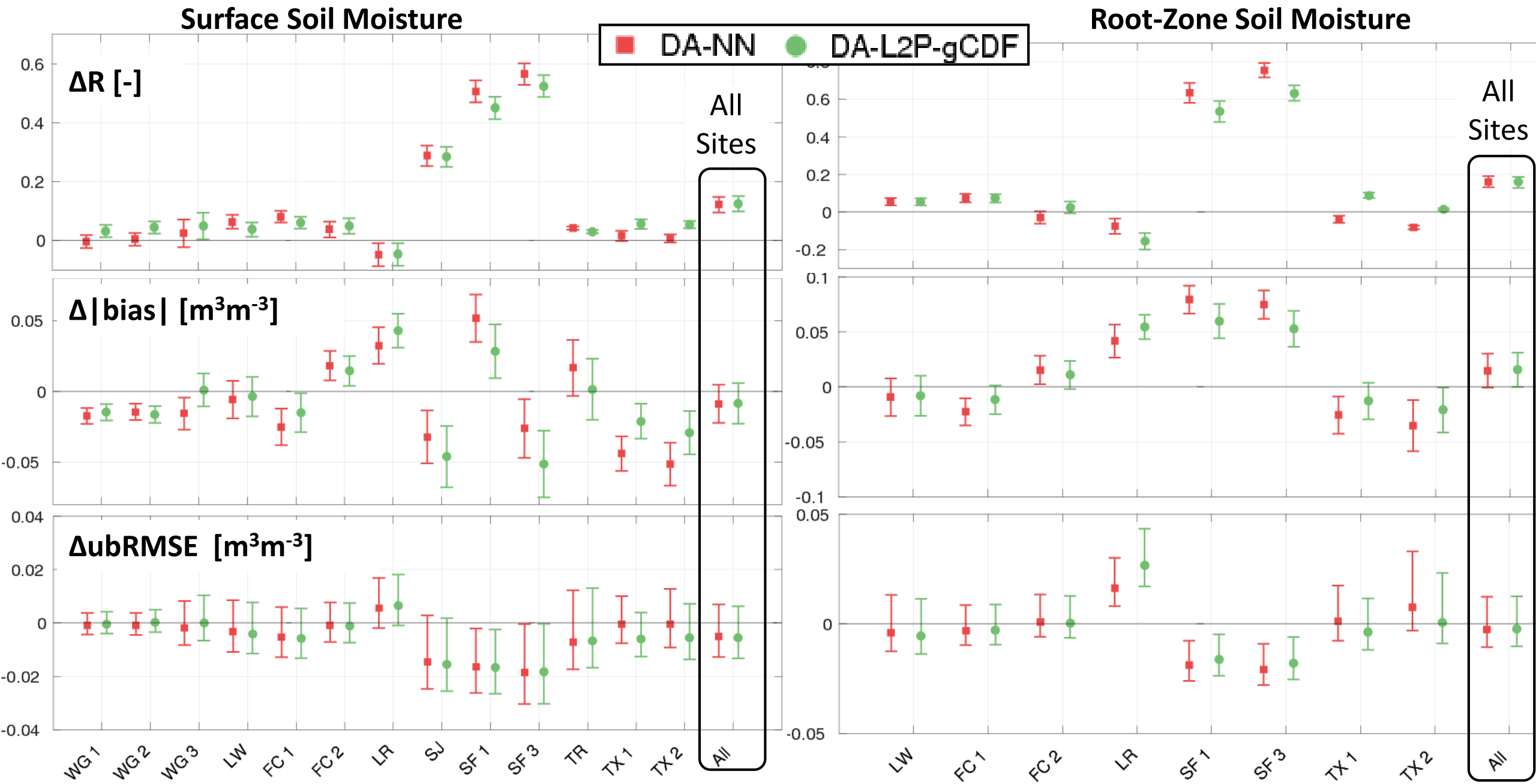


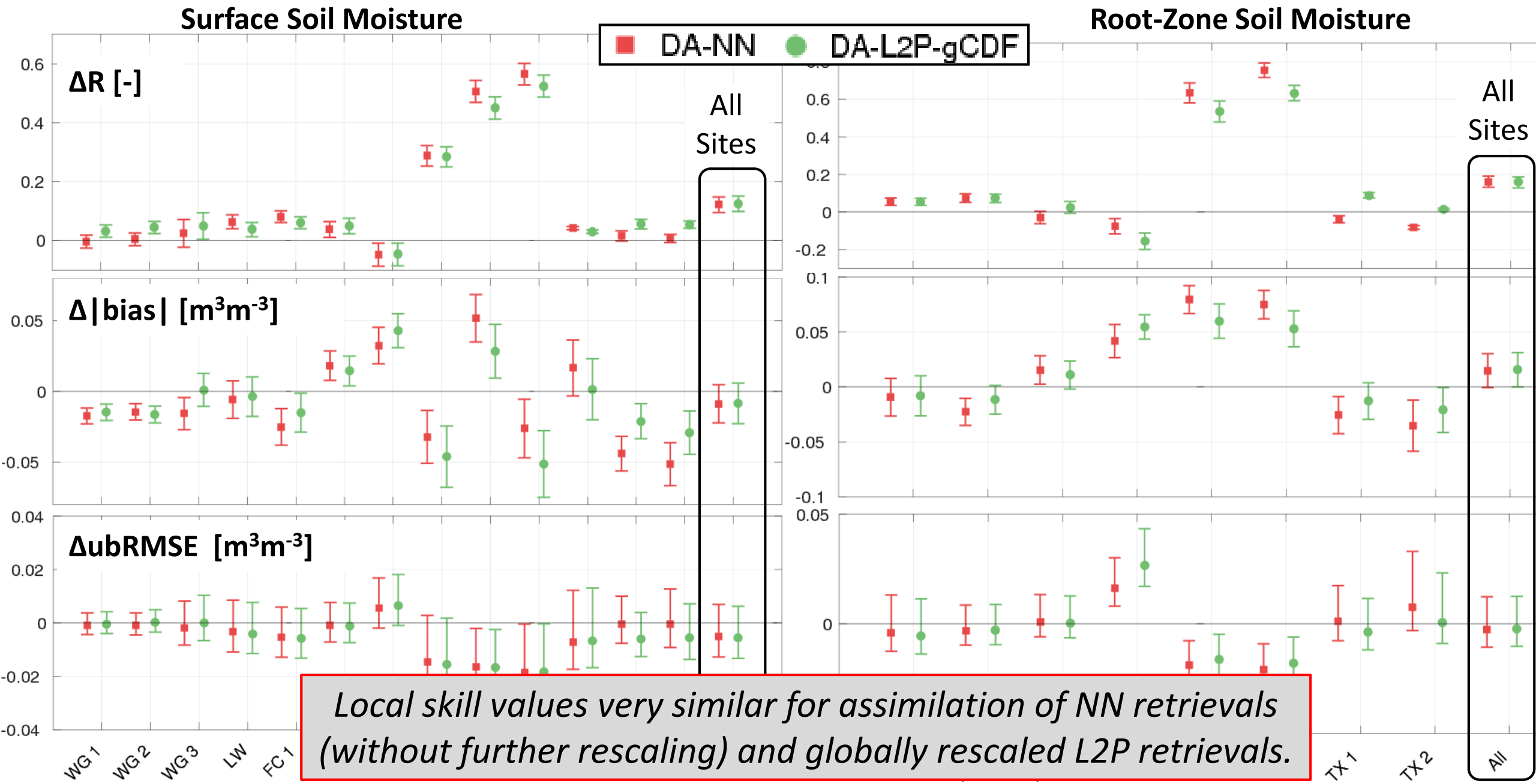




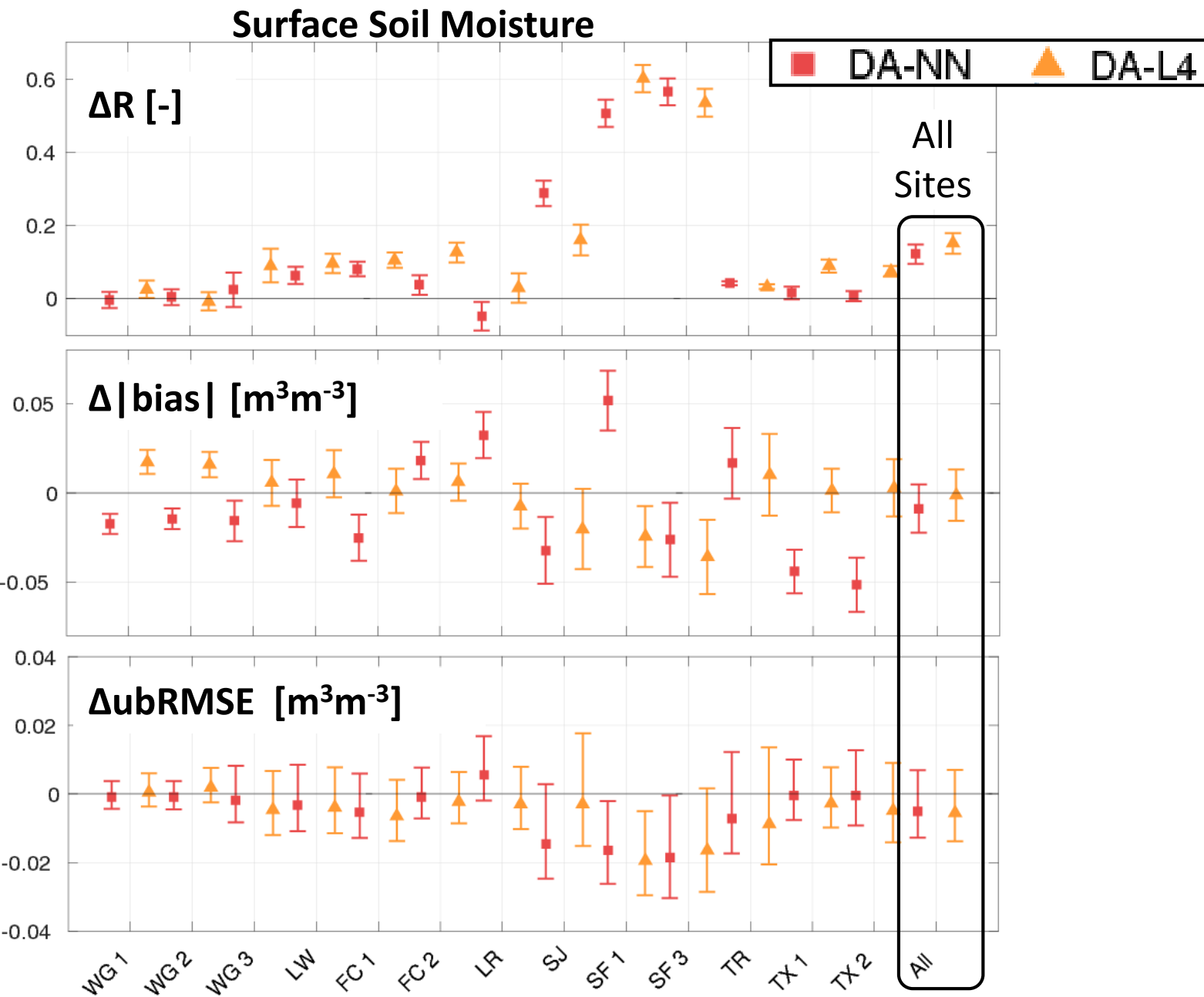
## Surface Soil Moisture



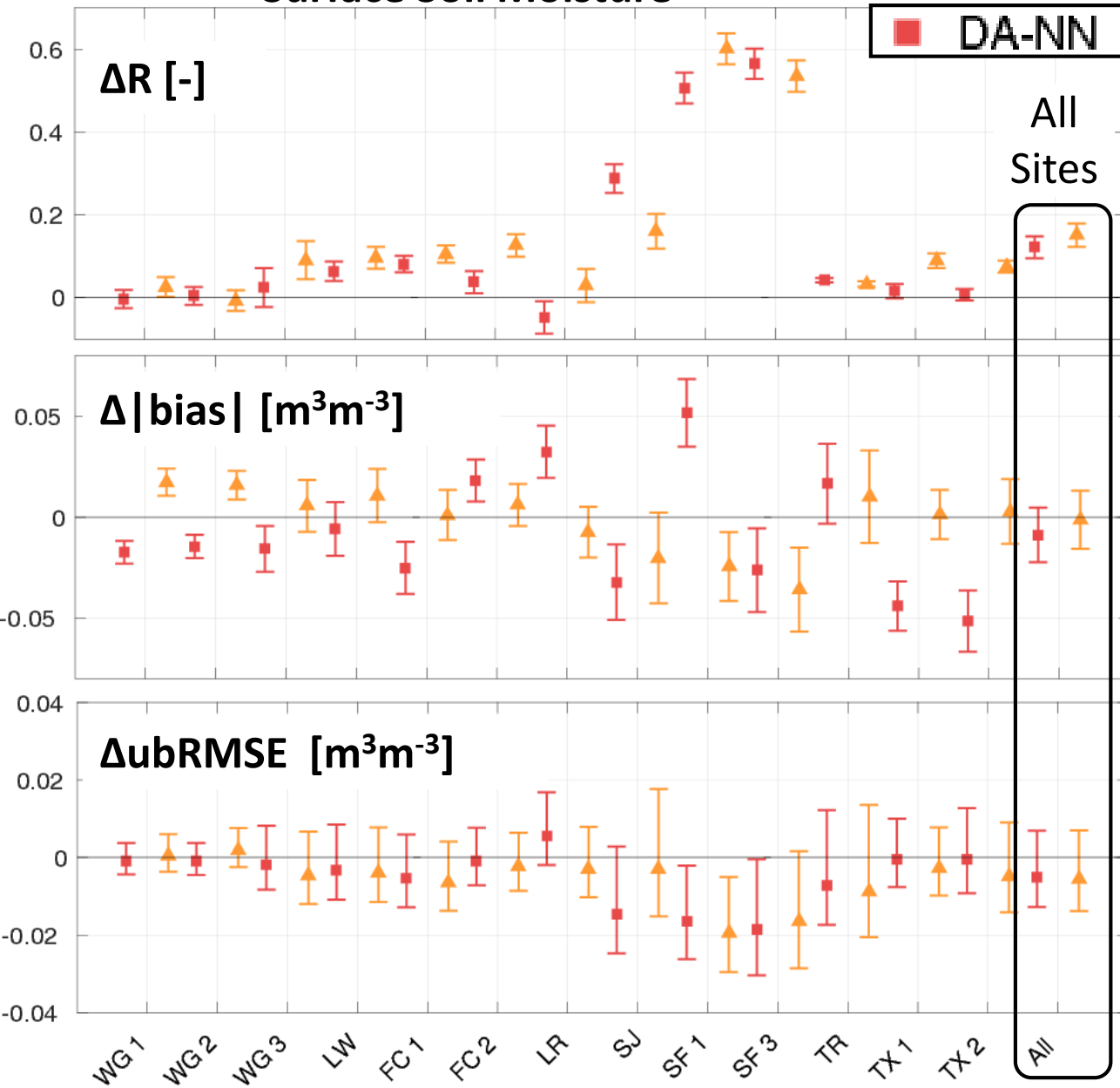




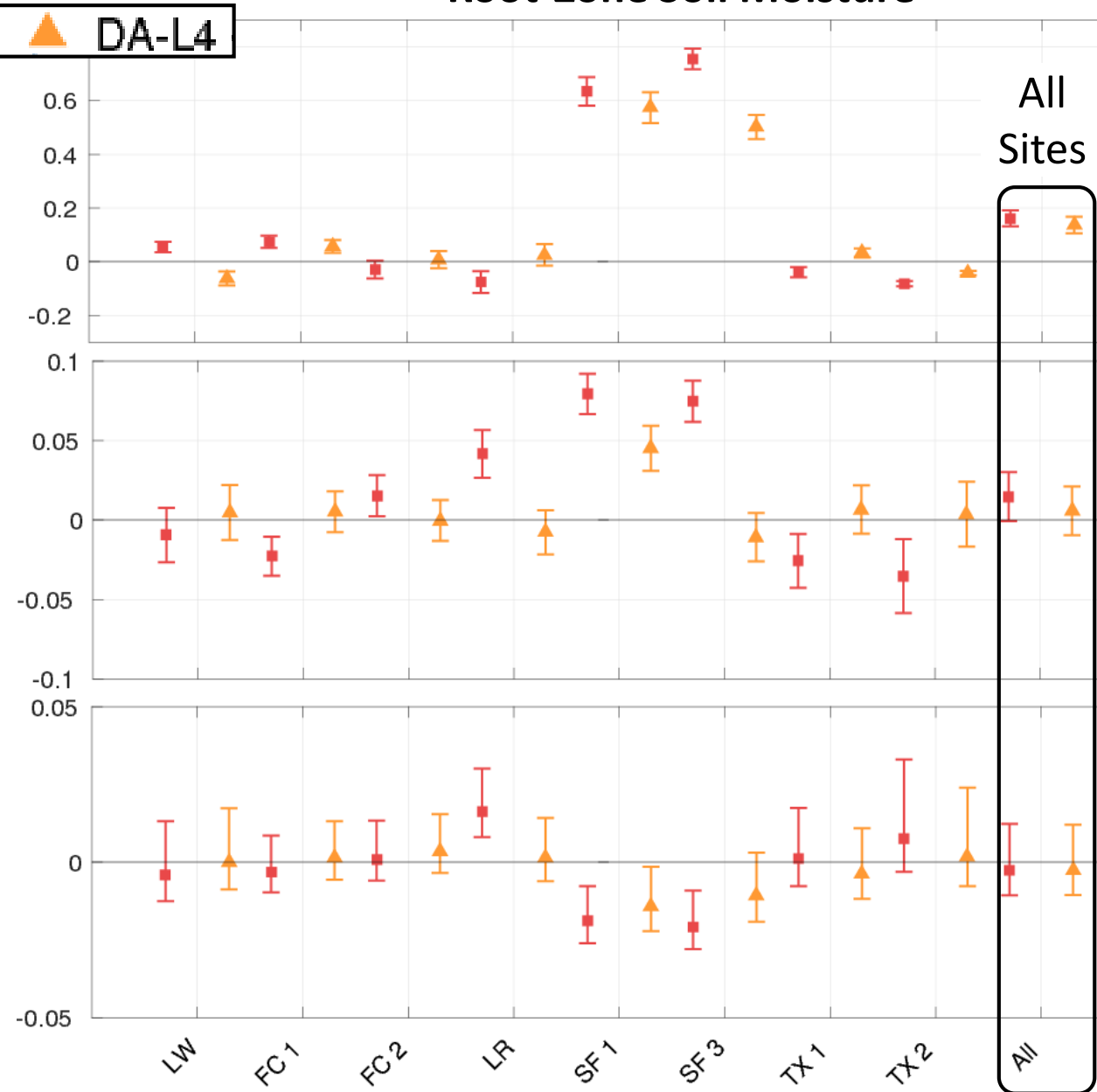


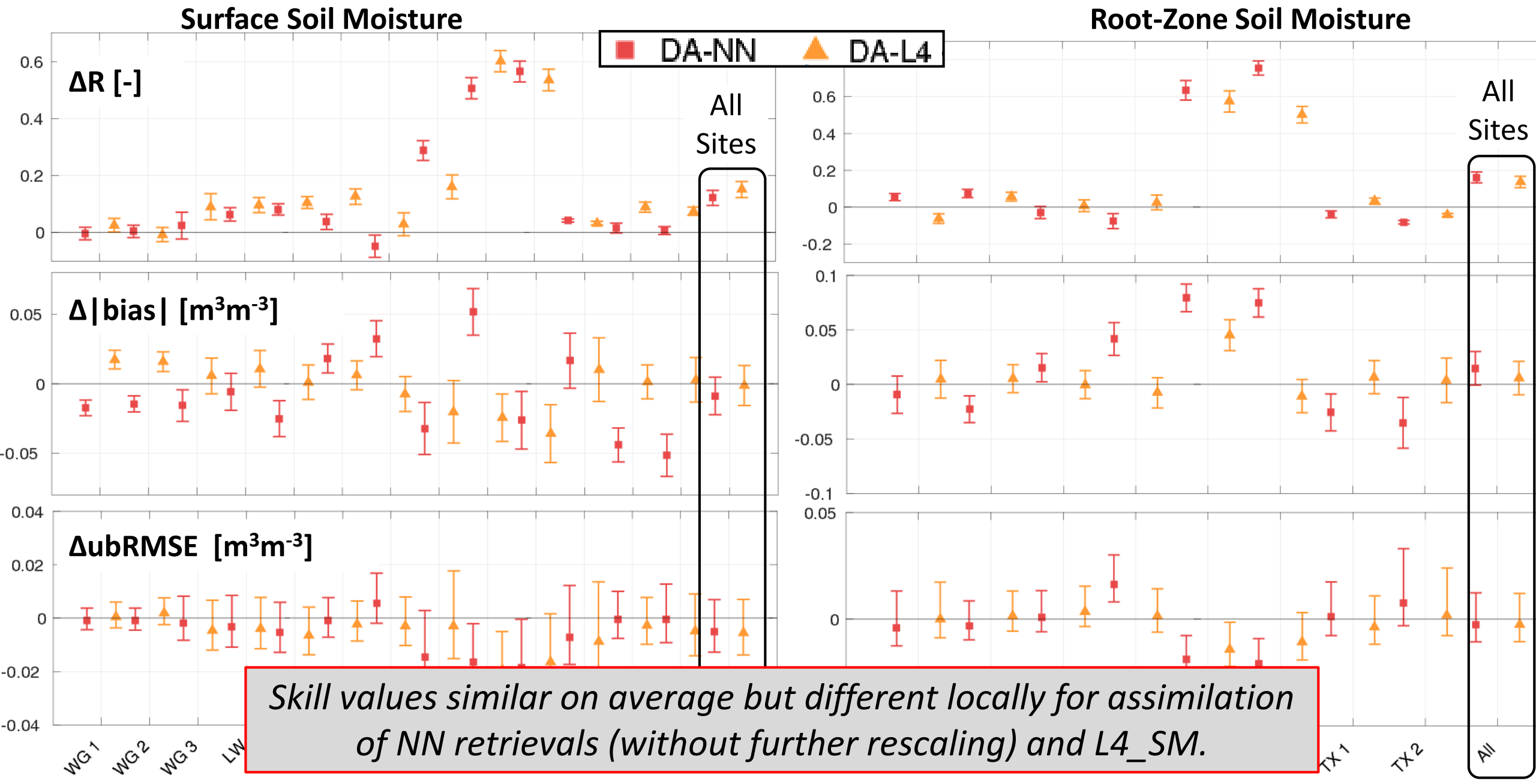


Surface Soil Moisture

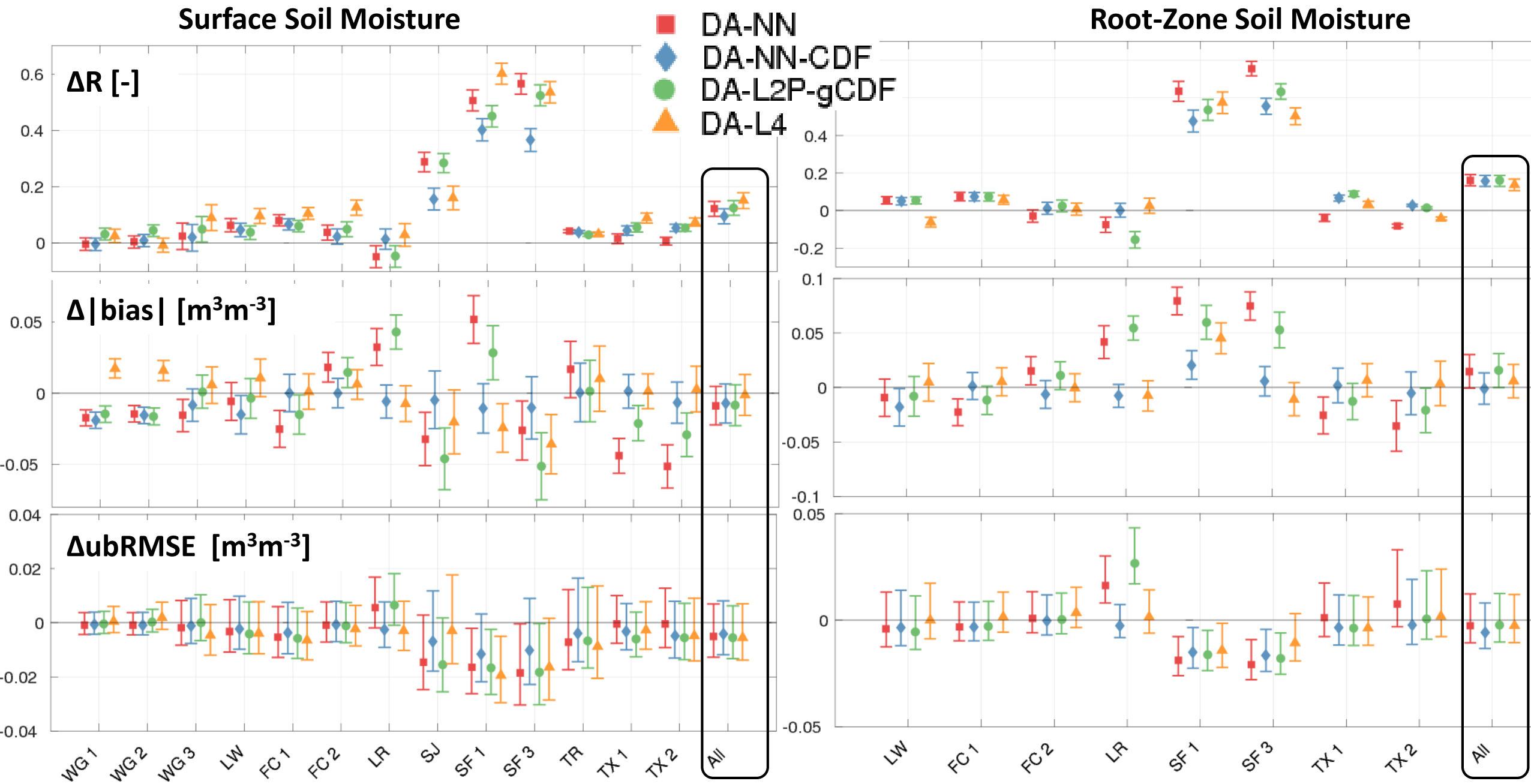


Root-Zone Soil Moisture

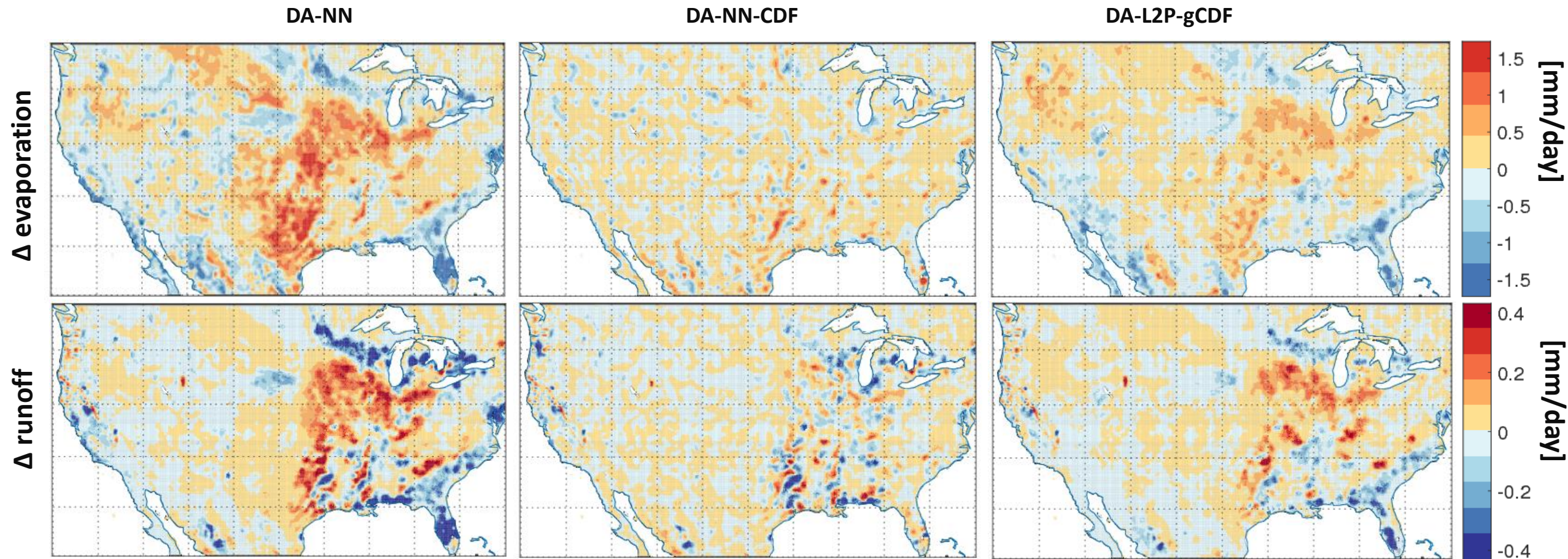




## Evaluation vs. In Situ Measurements







**Fig 5.** Difference (OL minus DA) in mean evaporation and runoff.

*Evaporation and runoff changes reflect changes in soil moisture patterns where fluxes are sensitive to soil moisture.*

- Global bias correction retains more independent satellite information.
  - Potential for greater improvements over model skill.
  - Assimilation skill more sensitive to retrieval bias.
  - Good QC and error characterization is crucial.
- Assimilation of NN and L2P retrievals (w/ global rescaling) results in very similar local skill values.
- Soil moisture and Tb assimilation have similar average skill with local differences.
- Evaporation and runoff changes reflect changes in soil moisture patterns.

Kolassa, J., et al. (2017a), Estimating surface soil moisture from SMAP observations using a Neural Network technique, *(in review)*.

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Colliander, A., et al. (2017), Validation of SMAP surface soil moisture products with core validation sites. *Remote Sensing of Environment*, 191.

Jackson, T.J., et al. (2016), Calibration and Validation for the L2/3 SM P Version 3 Data Products, SMAP Project, *JPL D-93720*, Jet Propulsion Laboratory, Pasadena, CA.

O'Neill, P., et al. (2015), SMAP Algorithm Theoretical Basis Document: L2 & L3 Radiometer Soil Moisture (Passive) Products. SMAP Project, *JPL D-66480*, Jet Propulsion Laboratory, Pasadena, CA.